C.I.R.P.É.E

Centre Interuniversitaire sur le Risque, les Politiques Économiques et l'Emploi

Cahier de recherche/Working Paper **07-06**

Humanitarian Relief and Civil Conflict

Max Blouin
Stéphane Pallage

Mars/March 2007

Blouin: CIRPÉE and Dept. of Economics, Université du Québec à Montréal
Pallage: Corresponding author. CIRPÉE and Dept. of Economics, Université du Québec à Montréal, PO Box 8888 (Downtown Sation), Montréal, QC, Canada H3C 3P8 / Tel.: (514) 987-3000 (8370)
pallage.stephane@uqam.ca

We thank Joost de Laat, Claude Fluet and Elena Panova for comments on earlier drafts. This research was financed by grants from SSHRC (Canada) and FQRSC (Quebec).

Abstract:
We examine the effects of famine relief efforts (food aid) in regions undergoing civil war. In our model, warlords seize a fraction of all aid entering the region. How much they loot affects their choice of army size ; therefore the manner in which aid is delivered influences warfare. We identify a delivery plan for aid which minimizes total recruitment in equilibrium.

Keywords: Humanitarian aid, food aid, civil war, warlords, famine

JEL Classification: O10, F35, D74

1 Introduction

Humanitarian relief benefits more than just those in need of help. Aid agencies hire local personnel, buy local goods, rent local means of transportation, pay bribes, make deals, etc. And millions of dollars' worth of aid assets are stolen. Much of this commercial and appropriative activity is organized by a regional potentate or warlord. Sometimes "organized" is not the right word, but the proceeds do trickle upwards. Attracting food aid, as journalists and humanitarian aid workers have testified, has become an end it itself (Maren, 1997; Shawcross, 2000; Shearer, 2000).

This is all amplified during civil conflict. The atmosphere of confusion, proliferation of weaponry, and erosion of property rights and accountability which accompany civil war multiply opportunities for appropriation by warlords.

Stolen aid is put to many uses. Aid agencies know this, and expect part of their shipments to be stolen. Weiss and Collins (2000) explain:

> Combatants steal or extort relief assets for a number of reasons: to sell or trade them in exchange for other assets, such as guns or land mines; to feed combatants and provide them with medical supplies (...) and to use in exchange for sexual favors. In addition to humanitarian goods, combatants may receive cash for providing protection to relief workers or relief warehouses and for allowing access to certain roads, airfields, or ports. (...) Relief agencies have often implicitly or explicitly cut deals and accepted that a portion of their relief assets will be diverted to combatants — a kind of "tax" or "cost of doing business" in war zones.

In this paper, we study a country undergoing both food shortage and civil conflict. Farmers are unable to raise enough food to survive. Some of them are recruited by warlords. Then an aid agency provides relief to the rest. When delivering aid, the agency must choose a port of entry, and each port is controlled by a different warlord. A fraction of all aid is stolen at the port of entry by the local warlord.

Though the agency delivers aid *after* the warlords have recruited soldiers and done battle, it can make an announcement *prior* to recruitment. This announcement details how aid will be delivered, i.e. which port(s) of entry will be used, contingent on the size of each warlord's army. We assume — sensibly enough, we think — that the agency cannot credibly commit to withholding aid from those who need it. But the agency's instrument is the way in which the aid is delivered, not the amount. Since the agency is indifferent to how the aid is delivered, its announcement is credible.

We identify a delivery plan which, in equilibrium, induces the lowest possible combined recruitment by warlords. The implication is that humanitarian aid can be used strategically to reduce the size of warlords' armies.

The following section provides a survey of the related literature. Section 3 provides the details of the model and the recruitment-minimizing equilibrium. Section

4 interprets the results and discusses some of the assumptions. This is followed by a short conclusion.

2 Related Literature

Food aid agencies suffer from a Samaritan's dilemma.[1] The Samaritan's dilemma is exacerbated by a commitment problem. In Blouin and Pallage (2007), we show that the existence of a food aid agency is likely to induce man-made famines which cannot be credibly addressed by the agency with threats of inaction. In the present paper, we abstract from Samaritan-type considerations and focus on an economy plagued by famine and on the verge of armed conflict. For whatever reason, every individual in the economy (except the warlords) faces a food shortage. We show that the aid agency can have a determinant impact on the belligerents' military choices. While it cannot prevent conflict, the agency can certainly limit its scope.

Food aid has been studied intensively by economic researchers, from its effectiveness at consumption smoothing (see Srinivasan, 1989; Gupta, Clements and Tiongson, 2004), to its possible disincentive effects on local food production and its spillovers on international food trade (see Isenman and Singer, 1977; Barrett, Mohapatra and Snyder, 1999; Barrett, 2001; Abdulai, Barrett and Hoddinott, 2005), and its diversion away from the most needy (see Jayne et al., 2001). We provide a very different perspective on food aid: its strategic use to minimize armed conflict.

In the equally vast literature on civil conflicts, few papers analyze the role of foreign aid as an instrument of peace. Collier and Hoeffler (2002) suggest that development aid does not have a direct effect on the probability of conflict, but that economic growth does. To the extent that foreign aid has an impact on growth, it may, therefore, indirectly promote peace. For a review of the conflicting evidence on aid's impact on growth, see Easterly (2003).

Most literature review on civil conflicts start with Grossman (1991). An insurrection in Grossman's model is an activity competing with productive activities. The equilibrium time allocated to insurrections depends on the ruler's kleptocratic behavior and the technology of revolutions. Competition between the incumbent ruler and a challenger is endogenized in Grossman (1999). Coalition formation in a game-theoretic context has been analyzed in depth by Skaperdas (1998) and Garfinkel (2004). Skaperdas (2002) examines a simple conflict between warlords; in his model there is no role for an aid agency, or any outside party. Our goal in this paper is to highlight the strategic importance of food aid in such conflicts.

We do not attempt to explain the cause of famines. Our model is compatible with both leading approaches: food availability decline (FAD) and failure in exchange entitlements (FEE). FAD means there is not enough food in the economy to feed everyone; FEE means there *is* enough food, but people starve anyway because of

[1] Samaritan dilemmas are typical of aid relationships (Buchanan, 1975) and have been evidenced in the context of development aid by Pedersen (2001) and Hagen (2006).

uneven wealth distribution. Sen (1981) is the classic reference for the FEE approach. In our setup, no one except warlords has enough to eat; but when warlords' wealth is included, there may or may not be enough food in the country to feed everyone.

3 The Model

3.1 Setup

The action takes place in a small country undergoing civil conflict. There are two airports, A and B. Any food aid sent must pass through one of these airports. There are two warlords, each in control of one airport. So we will call the warlords A and B as well. The model and results could be extended to N airports and warlords.

There is a population of measure 1 in the country. Initially everyone is a farmer. Each individual must consume 1 unit to survive. In the time frame considered, however, each individual can only raise $y < 1$ on his land. There are two ways to avoid starvation: become a soldier for one of the warlords, or receive food aid. If an individual becomes a soldier, he forgoes his crop and needs a salary of 1 to survive. If he remains a farmer, he gets his crop of y and needs $1 - y$ in aid.

The relation between the two warlords is one of appropriative conflict. Warlord $i \in \{A, B\}$ has initial wealth W_i. He hires an army of size s_i, paying each soldier his subsistence level. Then the two armies do battle. After the battle, but prior to the aid agency entering the scene, the payoff to warlord i is

$$\pi_i = \left(\frac{s_i}{s_i + s_j}\right)[W - s_i - s_j] \quad ; \tag{1}$$

where $W \equiv W_A + W_B$. The expression in brackets is the combined wealth of both warlords after soldiers have been paid. The expression in parentheses measures the share of wealth accruing to warlord i; it is a standard contest success function (see for example Tullock, 1980; Hirshleifer, 1988). We assume that each warlord remains in control of his airport, no matter what the oucome of the battle.

We assume $W < 2$. Since $W = 1$ would be enough to hire the country's entire population, this does not seem unreasonable.

We do not model the hiring process explicitly. It may be that soldiers are conscripts. Or it may be that soldiering is voluntary: at the wage offered by the warlords, individuals can either enlist or wait for aid. In the latter case, one could argue that a premium would have to be paid to soldiers for the risks they are taking. On the other hand, there is sufficient evidence that civilians are as much at risk as soldiers (if not more) during civil conflict (see Azam, 2002, and sources therein). We do not include a premium.

Once the fighting is over, a single agency brings food aid to civilians. All food brought into the country must pass through one of the airports. At the airport, whether it is A or B, a fraction θ of the incoming food is appropriated by the warlord in control of that airport. This fraction is exogenous; we discuss this assumption in section 4. The agency expects this, so if it wants an amount x to reach potential famine victims, it must send in $x/(1-\theta)$, knowing that $\theta x/(1-\theta)$ will be stolen.

Although we refer to θ as a proportion of aid that is stolen, we take it to mean all manner of benefits accruing to a warlord from having a shipment of aid go through territory which he controls. This includes the proceeds of theft, corruption, extortion, as well as some legitimate activities, such as trade and work.

We assume that all theft takes place at or near airports. We abstract from transportation costs. And we assume that all individuals who need to be fed are equally accessible from either airport. These are strong assumptions, admittedly, and they will be discussed further in Section 4. The main point is that, from a logistical standpoint, there is no material advantage in using one airport rather than another when delivering food to any part of the country. We make these abstractions because our aim is to highlight the potential for aid agencies to choose ports of entry *strategically*, i.e. with a view to curbing warfare.

The exact timing of the game is as follows. First, the aid agency announces how aid will be distributed once the hostilities are over, i.e. what proportion of aid will go through which airport. This can be an allocation rule contingent on army sizes s_A and s_B. Second, warlords simultaneously choose army sizes, then wage war on each other. Finally, the agency delivers aid. There is no discounting.

The choice of airports does not affect how many lives the agency can save. Indeed, when the time comes to deliver aid, the agency is indifferent among all delivery plans. So it sees no reason to deviate from what it said it would do. Therefore its opening announcement is credible.

The agency's objective is to minimize the total number of deaths from starvation. However, we assume that its budget is always sufficient to feed all non-combatants. It may have as a secondary objective the minimization of warfare, and this is what we will turn our attention to now. Although we will not make warfare minimization an equilibrium requirement, we will use it as a criterion for comparing equilibria. The extent of war will be measured simply by the total number of soldiers $s \equiv s_A + s_B$. Though other measures, such as the product of s_A and s_B, might better represent the actual intensity of conflict, the sum of the two is actually more manageable. And to the extent that the more people are mobilized the farther we are from a situation of peace, the sum will answer our purpose quite well.

3.2 The situation without aid

We first of all consider the situation in the absence of food aid. In that case each warlord's payoff is given by (1). Warlord i chooses s_i to maximize π_i given s_j. The solution is $s_A = s_B = W/4$. Total recruitment is $s = W/2$.

3.3 The situation with aid

We now reintroduce the aid agency. The agency announces a delivery plan, which is to say a function $\alpha(s_A, s_B)$ specifying, for given army sizes s_A and s_B, what fraction of the total aid sent will go through airport A. The remainder, a fraction $1-\alpha(s_A, s_B)$, will go through airport B.

The amount of aid that will be required will be $(1-s_A-s_B)(1-y)$. The agency, if it carries out its announced plan, will send in $(1-s_A-s_B)(1-y)/(1-\theta)$, a fraction θ of which will be seized. For conciseness define $Q \equiv \theta(1-y)/(1-\theta)$.

Anticipating that the agency will carry out its announced plan, warlord A chooses s_A to maximize

$$\pi_A = \left(\frac{s_A}{s_A+s_B}\right)[W - s_A - s_B] \quad + \quad \alpha(s_A, s_B)(1-s_A-s_B)Q \quad ; \tag{2}$$

while warlord B chooses s_B to maximize

$$\pi_B = \left(\frac{s_B}{s_A+s_B}\right)[W - s_A - s_B] \quad + \quad [1-\alpha(s_A, s_B)](1-s_A-s_B)Q \quad ; \tag{3}$$

In (2) and (3) we can refer to the first term on the right-hand side as the *war term*, and to the second term as the *aid term*.[2]

An equilibrium is a strategy profile $(s_A, s_B, \alpha(s_A, s_B))$ such that $s \leq 1$; s_A maximizes π_A given s_B and $\alpha(s_A, s_B)$; and s_B maximizes π_B given s_A and $\alpha(s_A, s_B)$. The agency's plan $\alpha(s_A, s_B)$ is optimal for the reasons given above. In what follows we deal only with pure strategies. We wish to emphasize, however, that all our results generalize to mixed strategies as well. The notation and proofs are slightly more involved when mixed strategies are considered; it is for the sake of simplicity that we restrict attention to pure strategies.

Consider the following delivery plan:

$$\alpha^*(s_A, s_B) = \begin{cases} 1 & \text{if} \quad s_B > \max\{s_A, m\} \quad ; \\ 0 & \text{if} \quad s_A > \max\{s_B, m\} \quad ; \\ 1/2 & \text{otherwise} \quad ; \end{cases} \tag{4}$$

$$\text{where} \qquad m = \max\left\{0, \left[\frac{2\sqrt{W} - \sqrt{4W - 2(2+Q)(W-Q)}}{2(2+Q)}\right]^2\right\} \quad . \tag{5}$$

This plan is illustrated in Figure 1. It is designed to incite the warlords to choose $(s_A, s_B) = (m, m)$, so that $s = 2m$. In fact the quantity m is constructed as the

[2]This should be compared to Skaperdas (2002). The contest success function $s_i/(s_i+s_j)$ measures the fraction of the spoils of battle going to warlord i. Equations (2) and (3) are arrived at by supposing that soldiers get paid before battle, and that aid is stolen afterwards (or at least in such a way that it cannot be fought over). Skaperdas assumes the contrary, .i.e. that soldiers are paid after battle and that warlords fight over some resource such as aid.

smallest army size which makes the warlords conform to the plan. If it were any smaller, one of the warlords would want to deviate by choosing an army size well above m, thus forgoing all aid but more than making up for it by the increase in his war term. Warlords' combined payoffs under this plan are $\pi_A + \pi_B = W + Q - 2(1+Q)m$. Below we show that no equilibrium has a smaller value of s or higher combined payoffs for the warlords. Note in particular that $m = 0$ if $W \leq Q$.

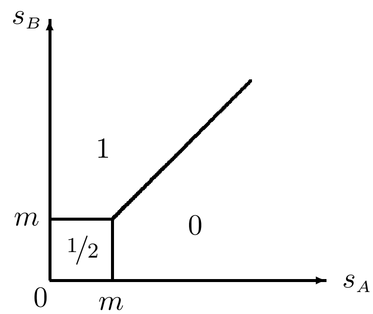

FIGURE 1. Fraction of aid going through airport A under delivery rule $\alpha^*(s_A, s_B)$.

Proposition 1. *The profile* $(m, m, \alpha^*(s_A, s_B))$ *is a subgame-perfect equilibrium.*

Proof. See appendix.

Proposition 2. *The profile* $(m, m, \alpha^*(s_A, s_B))$ *is the only subgame-perfect equilibrium in which the aid agency plays* $\alpha^*(s_A, s_B)$*.*

Proof. See appendix.

Proposition 1 shows us an equilibrium with aid. Proposition 2 establishes that once $\alpha^*(s_A, s_B)$ is announced and believed, this is the only equilibrium possible. In this equilibrium total rescruitment is $s = 2m$. This is less than $W/2$, the result when aid is absent. As we will see presently, no equilibrium yields lower total recruitment.

Proposition 3. *There is no subgame-perfect equilibrium with* $s < 2m$*.*

Proof. See appendix.

Proposition 4. *There is no subgame-perfect equilibrium with* $\pi_A + \pi_B > W + Q - 2(1+Q)m$*.*

Proof. See appendix.

Proposition 4 follows rather simply from Proposition 3, the reason being that smaller armies mean higher payoffs for everyone, including warlords. And yet peace — or any reduction in the level of armament, really — is difficult to achieve. That is the familiar inefficiency of appropriative conflict: each player has one eye on the enemy's guns and the other on the enemy's gold. He must guard against an attack on his own wealth, and at the same time cannot let an opportunity for acquisition go by.

Note that if $W_A = W_B$, the deployment of soldiers does not necessarily mean bloodshed. Since the equilibrium is symmetric, each warlord ends up with exactly his net resources (initial wealth minus payroll), plus looted aid. No resources actually pass from one warlord to another. This can be interpreted as either a conflict which ends in a draw (with loss of life on both sides), or as a standoff in which each warlord's army is just large enough to deter aggression from the other.

4 Discussion

4.1 Other plans

Delivery plan $\alpha^*(s_A, s_B)$ keeps army sizes at least as low as under any other plan; in particular, they are lower than they would be if aid were not distributed strategically. If $\alpha(s_A, s_B) = \alpha$ regardless of s_A and s_B (i.e. a constant fraction goes through each airport), then total army size ends up being $s = W/(2 + Q) > 2m$.

One might wonder what happens if the agency announces that all aid is to pass through the airport corresponding to the smaller army, and half through each airport in the event of a tie:

$$\alpha(s_A, s_B) = \begin{cases} 1 & \text{if} \quad s_A < s_B \quad ; \\ 0 & \text{if} \quad s_A > s_B \quad ; \\ 1/2 & \text{if} \quad s_A = s_B \quad . \end{cases} \tag{6}$$

Under this plan there is no pure-strategy equilibrium. When $s_A = s_B > 0$ each warlord has an incentive to undercut the other slightly; when $s_A \neq s_B$ one always has an incentive to move toward the other. And $s_A = s_B = 0$ is not an equilibrium either if $W > Q$: in that case each warlord has an incentive to hire a few soldiers, exchanging the payoff $(1/2)(W + Q)$ for the entire wealth W. If $W \leq Q$ then $s_A = s_B = 0$ *is* an equilibrium, but then the above plan coincides with $\alpha^*(s_A, s_B)$.

4.2 Transportation, accessibility

The model's strongest assumption is that of equal accessibility of any part of the country from either airport. In reality, can one channel a food shipment through airport A and ship it to a village near airport B without having any of it stolen by warlord B? Probably not. But even so, there are definite advantages to warlord A from the agency's use of his port of entry: aside from looting, there is the establishment of the agency's local headquarters, rental of vehicles, etc., from his neighborhood or region. It is on these advantages that we wish to focus.

Another factor to be considered is the fact that war creates massive displacements of population. People flock mainly to where they expect food to be, which often means humanitarian aid distribution centers and refugee camps. In going to these places they often travel long distances, crossing areas controlled by different warlords. In those cases, since people come to the food, transportation and accessibility are lesser issues for the agency. Then the interpretation of the distribution plan $\alpha(s_A, s_B)$ can be extended not only to the choice of airport but to the location of distribution centers and refugee camps. According to Maren (1997), these are the places where the most looting occurs, with the possible exception of ports of entry.

In addition, we should mention a possible probabilistic interpretaton of $\alpha(s_A, s_B)$. We have referred to $\alpha(s_A, s_B)$ as the proportion of aid channeled through airport A. It can also be interpreted as the probability that *all* of the aid will go through airport A. Then, assuming warlords are risk-neutral, the analysis remains the same. The agency may indeed prefer sending all aid through a single airport. This means having one headquarters, therefore lower set-up costs and less personnel. This provides additional justification for abstracting from transportation costs on the ground: the efficiency gains from sending everything through a single airport might outweigh all other considerations.

4.3 Amount of aid required

We have stated that the agency's main concern is saving lives, and that it has the resources to help anyone who needs it. Since we have emphasized a delivery plan which minimizes total recruitment, we are implicitly saying that the agency's secondary objective, at the time that it announces its plan, should be to minimize army sizes. Smaller army sizes mean more people in need of aid. The plan $\alpha^*(s_A, s_B)$ is therefore the costliest in terms of the amount of aid the agency is required to bring in. We are therefore suggesting that keeping army sizes to a minimum ought to take precedence over keeping aid requirements to a minimum.

4.4 Endogenizing the incidence of theft

In our model we have treated θ, the proportion of aid that is stolen, as exogenous. In reality, warlords could attempt to increase this fraction, at the cost of some resources (money or personnel). Azam (2002) addresses the issue of how warlords allocate their resources between fighting and looting. We refer to his work for insights into this question.

Conversely, the aid agency could, with increased vigilance, reduce this fraction. One thing certainly worth mentioning is that m is decreasing in θ for $\theta < W/(1-y+$

$W) \equiv \theta^*$ and equal to zero for $\theta \geq \theta^*$ [see equation (5)]. This would suggest allowing θ to *increase* to θ^* (if it is originally below this value) as a means for the aid agency to achieve peace in the country. Such decreased vigilance is tantamount to bribing the warlords not to deploy armies. Indeed increasing the warlords' payoff through decreased vigilance or through an outright side payment would be equivalent. The question is whether such a bribe is time-consistent. Once army sizes have been chosen, the agency has no clear incentive to go through with the proposed bribe. It cannot credibly commit to this strategy. We continue, therefore, to suppose that θ represents theft that the agency cannot prevent or does not find economically worthwhile to try to prevent.

5 Conclusion

We have identified a delivery plan for food aid which has a mitigating effect on the intensity of warfare in areas undergoing both famine and civil conflict. The plan calls for channeling aid through different ports of entry, according to whether the warlords controlling those ports keep the size of their army within set limits. In equilibrium warlords obey the plan, and as a consequence total deployment of soldiers is minimized. Even the warlords, because they spend less of their wealth on armament, benefit from this plan, at least in expected terms.

Clearly the precise conditions supposed in the model will not always be met in reality: transportation cost differentials, safety issues, as well as geographical and political considerations may favor using one port of entry over another. But in a broader sense, we hope to convey the general idea that the international community, through its aid agencies, ought to think of humanitarian aid strategically when sending it to an area of conflict — and this despite being neutral with regards to the said conflict. Warlords have long used humanitarian aid to their own ends; perhaps aid agencies can use warlords' greed to bring about a reduction in armaments.

References

Abdulai, A., Barrett, C.B. and Hoddinott, J. (2005). "Does food aid really have disincentive effects? New evidence from sub-Saharan Africa." *World Development* 33(10), 1689-1704.

Azam, J.-P. (2002). "Looting and conflict between ethnoregional groups: lessons for state formation in Africa." *Journal of Conflict Resolution* 46(1), 131-153.

Barrett, C.B. (2001). "Does food aid stabilize food availability?" *Economic Development and Cultural Change* 49(2), 335-349.

Barrett, C.B., Mohapatra, S. and Snyder, D.L. (1999). "The dynamic effects of U.S. food aid." *Economic Inquiry* 37(4), 647-656.

Blouin, M. and Pallage, S. (2007). "Addressing the food aid curse." Manuscript, Université du Québec à Montréal.

Buchanan, J. (1975). "The Samaritan's dilemma," in Phelps, E. (ed.), *Altruism, Morality and Economic Theory*. New York: Russel Sage Foundation.

Collier, P. and Hoeffler, A. (2002). "Aid, policy and peace: reducing the risks of civil conflict." *Defence and Peace Economics* 13(6), 435-450.

Easterly, W. (2003). "Can foreign aid buy growth?" *Journal of Economic Perspectives* 17(3), 23-48.

Garfinkel, M.R. (2004). "Stable alliance formation in distributional conflict." *European Journal of Political Economy* 20(4), 829-852.

Grossman, H.I. (1991). "A general equilibrium model of insurrections." *American Economic Review* 81(4), 912-921.

Grossman, H.I. (1999). "Kleptocracy and revolutions." *Oxford Economic Papers* 51(2), 267-83.

Gupta, S., Clements, B. and Tiongson, E.R. (2004). "Foreign aid and consumption smoothing: evidence from global food aid." *Review of Development Economics* 8(3), 379-390.

Hagen, R.J. (2006). "Samaritan agents? On the strategic delegation of aid policy." *Journal of Development Economics* 79(1), 249-263.

Hirshleifer, J. (1988). "The analytics of continuing conflict." *Synthese* 76(2), 201-233.

Isenman, P.J. and Singer, H.W. (1977). " Food aid: distinctive effects and their policy implications." *Economic Development and Cultural Change* 25(2), 205-37.

Jayne, T. S., Strauss, J., Yamano, T. and Molla, D. (2001). "Giving to the poor? Targeting of food aid in rural Ethiopia." *World Development* 29(5), 887-910.

Maren, M. (1997). *The Road to Hell: The Ravaging Effects of Foreign Aid and International Charity*. New York: Free Press.

Pedersen, K. R. (2001). "The Samaritan's dilemma and the effectiveness of development aid." *International Tax and Public Finance* 8(5-6), 693-703.

Sen, A.K. (1981). *Poverty and Famines: An Essay on Entitlement and Deprivation.* Oxford: Clarendon Press.

Shawcross, W. (2000). *Deliver Us from Evil: Peacekeepers, Warlords and a World of Endless Conflict*. London: Bloomsbury.

Shearer, D. (2000). "Aiding or abetting? Humanitarian aid and its economic role in civil war," in Berdal, M. and Malone, D.M. (eds.), *Greed and Grievance: Economic Agendas in Civil Wars.* Boulder, CO: Lynne Rienner Publishers.

Skaperdas, S. (1998). "On the formation of alliances in conflict and contests." *Public Choice* 96(1-2), 25-42.

Skaperdas, S. (2002). "Warlord competition." *Journal of Peace Research* 39(4), 435-446.

Srinivasan, T. N. (1989). "Food aid: a cause of development failure or an instrument for success?" *World Bank Economic Review* 3(1), 39-65.

Tullock, G. (1980). "Efficient rent-seeking," in J.M. Buchanan, R.D. Tollison and G. Tullock (eds.), *Toward a Theory of the Rent-Seeking Society.* College Station: Texas A&M University Press.

Weiss, T.G. and Collins, C. (2000). *Humanitarian Challenges and Intervention.* 2nd ed. Boulder, CO: Westview Press.

Appendix

A. Proof of Proposition 1

Suppose the agency plays $\alpha^*(s_A, s_B)$ and warlord B plays $s_B = m$. If warlord A plays $s_A = m$ his payoff will be $\pi^m \equiv (1/2)(W - 2m) + (1/2)(1 - 2m)Q$. The derivative

$$\frac{d\pi_A}{ds_A} = \left[\frac{mW}{(s_A + m)^2}\right] - 1 - (1/2)Q \tag{7}$$

is positive for all $s_A \leq m$, meaning that having an army smaller than m is sub-optimal. With $s_A > m$ the aid term drops to zero. In that range the optimal army size is $s_A = -m + \sqrt{mW}$, which yields a payoff exactly equal to π^m. Therefore the choice of $s_A = m$ cannot be improved upon. The same argument goes for warlord B. The agency, when the time comes to deliver aid, is indifferent among all its options, therefore its chosen strategy is optimal as well. □

B. Proof of Proposition 2

Assume throughout that the agency plays $\alpha^*(s_A, s_B)$.

Suppose $s_i > s_j > m$ in equilibrium. Setting $d\pi_i/ds_i = d\pi_j/s_j = 0$, we find $s_i = W(1 + Q)/(2 + Q)^2$ and $s_j = W/(2 + Q)^2$, which indeed satisfy $s_i > s_j > m$. But the payoff that warlord i obtains in this case is less than what he can get by choosing s_i slightly below s_j (thereby increasing his share of stolen aid from 0 to 1).

Suppose $s_i = s_j > m$. Here each warlord gets one half of stolen aid, but could increase this share to 1 by decreasing the size of his army by a small amount.

Suppose $s_i > m \geq s_j$. Setting $d\pi_i/ds_i = 0$ yields $s_i = -s_j + \sqrt{s_j W}$. This is indeed larger than m if $s_j \leq m$. But if warlord i chooses this size for his army, we have $d\pi_j/ds_j > 0$ for all $s_j \leq m$, meaning that warlord j would want to have an army size greater than m.

Finally suppose that $s_i < s_j = m$ or $s_i \leq s_j < m$. Then we have $d\pi_i/ds_i > 0$, meaning that warlord i would want to increase s_i. □

C. Proof of Proposition 3

Suppose there exists an equilibrium $(\tilde{s}_A, \tilde{s}_B, \alpha(s_A, s_B))$ where $\tilde{s} \equiv \tilde{s}_A + \tilde{s}_B < 2m$. Let $\tilde{\pi}_A$ and $\tilde{\pi}_B$ denote respectively the payoffs accruing to warlords A and B in this equilibrium. If warlord A chooses $s_A = -\tilde{s}_B + \sqrt{\tilde{s}_B W}$ instead of $\tilde{s}_A$, his war term becomes $\tilde{s}_B + W - 2\sqrt{\tilde{s}_B W}$. For $\tilde{s}_A$ to be optimal, then, we must have

$$\tilde{\pi}_A \quad \geq \quad \tilde{s}_B + W - 2\sqrt{\tilde{s}_B W} \quad . \tag{8}$$

Similarly we must have

$$\tilde{\pi}_B \quad \geq \quad \tilde{s}_A + W - 2\sqrt{\tilde{s}_A W} \quad . \tag{9}$$

Adding (8) and (9) together yields

$$\tilde{\pi}_A + \tilde{\pi}_B \quad \geq \quad \tilde{s} + 2W - 2\sqrt{\tilde{s}_A W} - 2\sqrt{\tilde{s}_B W} \quad . \tag{10}$$

The left-hand side of (10) is equal to $W - \tilde{s} + (1 - \tilde{s})Q$, and the right-hand side is no less than $\tilde{s} + 2W - 2\sqrt{2\tilde{s}W}$. Thus

$$W - \tilde{s} + (1 - \tilde{s})Q \quad \geq \quad \tilde{s} + 2W - 2\sqrt{2\tilde{s}W} \quad . \tag{11}$$

Straightforward algebra shows that (11) is incompatible with $\tilde{s} < 2m$. □

D. Proof of Proposition 4

From (2) and (3) we see that $\pi_A + \pi_B = W + Q - (1 + Q)s$. If an equilibrium has combined warlord payoffs greater than $W + Q - 2(1 + Q)m$, it needs to have $s < 2m$. But it was shown in Proposition 3 that this is impossible. □